ABSORPTION OF GLUCOSE FROM THE STOMACH OF THE DOG

by

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INTRODUCTION

Since the earliest investigations into the absorptive powers of the stomach have been conducted, especially those relating to the absorption of glucose, authorities have been unable to arrive at an agreement on the subject. The variety of results that have been obtained by the different workers in this field might be attributed to the fact that the technic employed by each one in anesthesia, operative procedure, and determination of the glucose content of the blood or of the fluid in the stomach has not been the same, and that the interpretation of the results obtained by each has been different.

Some authors who have conceded that glucose is absorbed by the gastric mucosa have qualified their statements by adding that the glucose, in order to be absorbed, must be of a concentration of at least five per cent, and that the rate of absorption varies directly with the concentration of the glucose in the stomach. A recent series of experiments relating to the absorption of hexoses from the stomach has shown that the coefficient of absorption, which has been defined as the number of grams of glucose absorbed per 100 grams of body weight per hour, is independent of the strength of the sugar solution. One physiologist states that "...the mucous membrane of the stomach is so crowded with peptic glands that the amount of absorbing surface is small. Recent experiments have shown that though absorption does take place in the stomach, it is not so active as was formerly supposed."

The methods which were employed by the various investigators had not been standardized, so that by reviewing the work which had been done in this regard no definite conclusions could be drawn insofar as absorption of glucose from the stomach is concerned.

It has been the purpose of this thesis to ascertain, by determining the amount of rise in blood sugar following intragastric introduction of glucose solutions, whether or not this sugar is absorbed by the gastric mucosa. The methods of procedure were selected as those which would give the least possible factor of error. Various control experiments were performed in an attempt to demonstrate that erroneous results were not obtained due to any hyperglycemic effect that the anesthesia or excessive manipulation of the viscera might have on the experimental animals, and to show that an increase in blood sugar could not be induced by the presence of solutions other than those of glucose in the isolated stomach.

REVIEW OF LITERATURE

Probably the first experiments dealing with gastric absorption, described by Gamgee (1893), were those performed by Tappeiner in 1881. Using dogs and cats as experimental subjects he ligated their pylori and then injected various solutions into the stomachs, noting the physiological effects of the introduced substances upon the animals. He concluded that the absorptive power of the stomach was greatly inferior to that of the intestine insofar as substances dissolved in water were concerned, but that it possessed the power of absorbing dilute alcohol as well as substances dissolved in it. He stated that the amounts of glucose absorbed from aqueous solutions were so small as to fall into the limits of experimental error.

According to Gamgee, Anrep in 1881 repeated Tappeiner's experiments on dogs with gastric fistulae, but his results indicated that sugar was absorbed in large quantities by the stomach. Gamgee described Smith's experiments performed in 1884 with frogs, in which he first ligated the pylori and then injected solutions of glucose into the stomachs. Smith found that the rate of absorption depended upon the concentration of the solution.

Gamgee quoted J. S. Edkins who found in 1882 that considerable absorption of glucose occurred from water solutions, and that the amount was increased when the glucose was in alcoholic solution. Gamgee also described the experiments of von Mering in 1893, who, without having known of Edkins' experiments, worked with dogs in which he had established duodenal fistulae, and also observed that glucose in aqueous solutions was absorbed by the stomach in large quantities, and when in alcoholic solutions was absorbed in still larger quantities. He stated that the amount of absorption depended upon the concentration of the solution.

The procedures for determining how glucose was absorbed were not given in the reference from which the aforegoing material was extracted, and it was impossible to obtain the original articles. However, because of the nature of the experiments that were performed later, it was assumed that the stomach contents, after a definite time interval following the introduction of sugar solutions into the stomach, were removed and analyzed quantitatively for the presence of glucose. The difference between the amount injected and the amount recovered was the quantity that was assumed to have been absorbed.

Nora Edkins (1928), using decerebrate cats, introduced twenty per cent aqueous solutions of glucose into the stomachs. At the end of one hour, she removed the fluid remaining in the stomachs, and determined quantitatively the amount of glucose which was still present in the fluid, thus computing the amount which had disappeared during the time it was permitted to remain in the stomachs. Her results indicated that about thirty milligrams of glucose had disappeared from the stomach of one of her experimental cats within an hour.

Edkins and Murray (1928), working with cats under amytal anesthesia, found that following injection of glucose solutions into the alimentary canal the blood sugar rose, probably indicating absorption. However, they had not occluded the pylori of their cats and the experiments were carried out over periods of eight hours each, so the rise in blood sugar was due to absorption from small intestine rather than from the stomach. A further indication of this was that the rise in blood sugar was not apparent for two hours. Normally, at the end of this period of time, the fluid would have passed from the stomach into the small intestine, where absorption of glucose is known to occur.

Maddock, Trimble, and Carey (1933) performed a series of experiments, using dogs under amytal anesthesia. They blocked the pylori and introduced glucose solutions into the stomachs. After a definite period of time, the animals were killed and the stomach contents removed. This fluid was chemically analyzed to determine the amount of glucose recovered. They also performed experiments in which samples of blood from the gastric veins were examined for a rise in blood sugar following the introduction of a glucose solution into the stomach of a dog. They reported the recovery of 99.3 ± 1.2 per cent of the glucose administered, and that any change which was evident in the blood sugar level was within the limits of experimental error.

EXPERIMENTAL PROCEDURE

In planning a procedure to follow during the course of these experiments, it was decided that a gastric fistula should not be employed, because a catarrhal condition usually accompanies the surgical intervention, and this would undoubtedly interfere with the normal absorptive powers of the gastric mucosa. Nembutal (Sodium ethyl-(1-methyl-butyl)-barbiturate) was selected for a routine anesthetic, because it produced profound and undisturbed sleep if given in the proper dosage and did not produce hyperglycemia. Dogs were used as subjects for these experiments. It was impossible to regulate the size of these animals, but all of them were in apparently normal health and in good condition, and had not been fed for at least twelve hours previous to the time of operation.

Operative Technic

Nembutal solution (one cc. containing one grain of the drug) was administered to each of the experimental animals in excess of the normal dosage of one cc. for each five pounds of body weight. An excess was given, because in preliminary trial experiments it was found that the glucose solution which was injected into the stomach caused partial recovery from anesthesia when the normal dosage of Nembutal was given. The drug was administered by intravenous injection into the external saphenous vein. When the pupils of the eyes had become constricted and the corneal reflex had disappeared, injection of the anesthetic was discontinued.

The experiments were performed in four series:

(1) Injection of fifty per cent glucose solution into the stomach: Each animal was placed in dorsal recumbency, and the ventral abdominal region was washed and shaved. In male dogs the prepuce was ligated to prevent the possibility of contamination of the operative area by involuntary micturition. An area on the ventral surface of the neck was also washed and shaved and an incision made to expose the esophagus. This organ was ligated to prevent the loss of fluids from the stomach by vomition or as a result of manipulation. An incision was made in the mid-ventral

line of the abdomen through the skin, muscle, and peritoneum, extending from the xyphoid cartilage to the umbilicus. Hemorrhage in the operative area was controlled by the use of ligatures and hemostats. The stomach was exposed and the pylorus ligated with a heavy suture to prevent the passage of fluid into the small intestine.

A preliminary blood sample was withdrawn from one of the gastric veins in the region of the lesser curvature and on the parietal surface of the stomach. The blood was drawn through a hypodermic needle of 19- to 22-gauge into a glass syringe containing 0.1 cc. of saturated ammonium oxalate solution as an anticoagulant. To prevent hemorrhage from the gastric veins following the withdrawal of blood, the vein was surrounded by a ligature of fine silk which was tightened and tied immediately after withdrawal of the needle.

Following the removal of the first blood sample, a solution of glucose (Merck, C.P.) of fifty per cent concentration was injected directly into the stomach. The usual quantity of the solution administered was twenty cc., which contained ten grams of the sugar. This large amount of sugar was given so that the maximum amount of absorption would occur.

At definite intervals following the introduction of the glucose solution, blood samples were withdrawn from the gastric veins in a manner essentially the same as that of the first sample.

Blood samples were drawn from the gastric veins because it was thought that if glucose was absorbed by the gastric mucosa, the first place that a rise in blood sugar would be detected would be in the blood immediately as it leaves the stomach. Blood was drawn from the veins on the parietal surface of the stomach in the region of the lesser curvature because of their large size, their ready accessibility, and the ease with which the blood could be withdrawn from them.

(2) Injection of four per cent glucose solutions into the stomach: As has been previously mentioned, some of the earlier workers stated that in order that glucose be absorbed from the stomach, it must be present in concentrations of at least five per cent. In this group of experiments, the procedure was identical with that of the preceding group, with the exception that a four per cent solution of glucose replaced the fifty per cent solution. The purpose of this group of experiments was to attempt to determine whether the statement of the earlier workers was true. If absorption of a four per cent solution of glucose did not occur, the results of this group would indicate the

effect that the lesser concentration had upon the rate of absorption.

(3) Injection of physiological saline solution into the stomach: The procedure in these experiments was the same as that employed in the sugar experiments, excepting that instead of administering a solution of glucose, physiological saline solution was given in a volume equivalent to that of the glucose solution given to the dogs in the first two groups. The purpose of this control group was to determine whether or not the presence of a substance other than glucose solution in the stomach would result in a rise in blood sugar.

(4) Anesthetic and manipulation controls: This group of experiments was performed in an attempt to determine whether or not the anesthetic (Nembutal) which was employed or excessive manipulation of the stomach would produce hyperglycemia. The same surgical procedure was followed in this group as in the other three, that is, ligation of the esophagus and pylorus and withdrawal of blood samples from the gastric veins. However, nothing was injected into the stomach; instead, this organ was subjected to extremely rough handling, taking care not to produce physical injury to the organ.

Attempts were not made to permit recovery of these test animals. All of them were destroyed either by cannulating the carotid artery, or by injecting chloroform or magnesium sulphate directly into the heart.

Chemical Procedure

A modification of the method of Folin and Wu (1920) was used routinely in determining the amount of glucose present in the blood samples. In this method, the protein-free blood filtrate is heated with an alkaline copper solution, using a special tube to prevent re-oxidation. Cuprous oxide is formed by the reducing action of the glucose on the cupric ion. The cuprous oxide is treated with an acid molybdate solution, and the blue color which is obtained is compared in a colorimeter with that of a standard.

To prepare the protein-free blood filtrate, two cc. of blood are very carefully measured and dropped from a pipette into 14 cc. of distilled water in an Erlenmeyer flask of 125 cc. capacity. Two cc. of 2/3 N. sulfuric acid are added, drop by drop, to this laked blood solution, shaking the mixture vigorously after each addition.

It is imperative that the blood be laked and acidified as soon after its withdrawal from the vein as possible to prevent hydrolysis of the glucose by certain enzymes present in the blood. This enzyme action begins about five minutes following removal of the blood and continues for about thirty minutes, after which time practically all of the glucose has been hydrolyzed.

After the laked blood is acidified two cc. of a ten per cent sodium tungstate solution are added to coagulate the proteins, and the mixture is shaken very vigorously. After having been allowed to stand five to ten minutes, the mixture is filtered. The filtrate should be perfectly clear and colorless if the proteins are precipitated properly. Duplicate filtrates are prepared from each sample of blood.

Two cc. of each of the protein-free filtrates are transferred to a 25 cc. Folin-Wu sugar tube. Two cc. of standard solutions containing 0.1 mg. and 0.2 mg., respectively, of glucose in each cc. of the solution, are also placed in sugar tubes. Duplicate standards are pmepared comparable to the duplicate blood filtrates. Two cc. of alkaline copper solutions are added to each tube. All of these tubes are placed in boiling water, where they are permitted to remain six minutes, after which they are removed and cooled in running water. Two cc. of acid molybdate reagent are added to the contents of each tube. After two minutes the contents are diluted with distilled water to the 25 cc. mark and mixed very thoroughly by inverting the tubes. The unknown samples are then compared colorimetrically with the standards. The amount of glucose present is determined by the use of the following equation:

$$\frac{\text{Reading of Standard}}{\text{Reading of Unknown}} \times \begin{matrix}\text{Mg. in}\\ \text{standard}\end{matrix} \times 100 = \begin{matrix}\text{Mg. glucose}\\ \text{in 100 cc.}\\ \text{of blood}\end{matrix}$$

RESULTS

As the experiments were conducted in four series, the results shall be discussed in four corresponding groups:

(1) Fifty per cent glucose experiments: Four dogs were treated in this group of experiments, and all of them exhibited similar increases in the glucose levels of the blood from the gastric veins in ten to forty minutes, after which the levels decreased similarly. Dog 1 showed a rise of 29.64 mg. of glucose per 100 cc. of blood in ten minutes following the injection of fifty per cent glucose solution into the stomach. The blood sugar of Dog 2 increased 22.62 mg. in 15 minutes, and that of Dog 3 increased 19.12 mg. in forty minutes. Dog 3 was given a smaller amount of glucose solution than that administered to the others because of its relatively smaller size. At the end of twenty minutes, Dog 4 showed an increase of 34.94 mg. In the case of Dog 4, at the end of a seventy minute period from the time the glucose solution was administered, the blood sugar rose from 111.11 mg. to 140.84 mg. This second rise could not

be accounted for definitely, but it was thought that there was secondary absorption following the initial increase.

According to the results obtained in this group of experiments, the average increase in blood sugar following the intragastric administration of a concentrated glucose solution was 27.84 mg. per 100 cc.of blood. This figure is between 25 and 33 per cent of the normal amount in the blood, which ranges between 70 and 100 mg. per 100 cc. of blood. Various physiologists state that the blood sugar level has a normal variation of about 30 mg., but because a rise with a subsequent lowering occurred consistently in all of the test animals, it was concluded that the increase was due to actual absorption. Since the pylorus and esophagus of each of the animals were occluded so that none of the fluid could escape from the stomach, it was also concluded that the absorption took place in the stomach.

The average time period for the greatest increase in blood sugar was found to be 21.25 minutes.

The individual results of this group of experiments are recorded in the following tables:

Table 1 (a). Fifty Per Cent Glucose Experiments.

Dog 1. (Two year old female; weight 22 pounds)

Time	Minutes after glucose	Treatment	Mg. glucose in 100 cc. blood
2:40 p.m.		4.5 cc. Nembutal intravenously	
2:50 p.m.		4.0 cc. blood from gastric vein	68.49
3:02 p.m.	0	20.0 cc. 50% glucose solution into stomach	
3:12 p.m.	10	4.0 cc. blood from gastric vein	98.03
3:27 p.m.	25	4.0 cc. blood from gastric vein	81.30
3:42 p.m.	40	4.0 cc. blood from gastric vein	75.75

Total rise in blood glucose: 29.64 mg.

Time of greatest rise following glucose injection: 10 minutes.

Table 1 (b). Fifty Per Cent Glucose Experiments.

Dog 2. (Two year old male; weight 53 pounds)

Time	Minutes after glucose	Treatment	Mg. glucose in 100 cc. blood
1:40 p.m.		8 cc. Nembutal intravenously	
2:07 p.m.		10 cc. blood from gastric vein	94.33
2:10 p.m.	0	20 cc. 50% glucose solution into stomach	
2:25 p.m.	15	10 cc. blood from gastric vein	116.95
2:40 p.m.	30	10 cc. blood from gastric vein	111.11
2:55 p.m.	45	10 cc. blood from gastric vein	105.82
3:15 p.m.	65	10 cc. blood from gastric vein	101.01

Total rise in blood glucose: 22.62 mg.

Time of greatest rise following glucose injection: 15 minutes.

Table 1 (c). Fifty Per Cent Glucose Experiments.

Dog 3. (One year old male; weight 12 pounds)

Time	Minutes after glucose	Treatment	Mg. glucose in 100 cc. blood
2:15 p.m.		3 cc. Nembutal intravenously	
2:34 p.m.		8 cc. blood from gastric vein	74.90
2:35 p.m.	0	10 cc. 50% glucose solution into stomach	
2:50 p.m.	15	8 cc. blood from gastric vein	87.73
3:15 p.m.	40	8 cc. blood from gastric vein	93.02
3:30 p.m.	55	8 cc. blood from gastric vein	78.20

Total rise in blood glucose: 19.12 mg.

Time of greatest rise following glucose injection: 40 minutes.

Table 1 (d). Fifty Per Cent Glucose Experiments.

Dog 4. (Aged male; weight 45 pounds)

Time	Minutes after glucose	Treatment	Mg. glucose in 100 cc. blood
1:40 p.m.		10 cc. Nembutal intravenously	
2:14 p.m.		8 cc. blood from gastric vein	89.28
2:15 p.m.	0	20 cc. 50% glucose solution into stomach	
2:25 p.m.	10	8 cc. blood from gastric vein	113.63
2:30 p.m.	15	8 cc. blood from gastric vein	112.99
2:35 p.m.	20	8 cc. blood from gastric vein	124.22
3:05 p.m.	50	8 cc. blood from gastric vein	111.11
3:20 p.m.	70	8 cc. blood from gastric vein	140.84*

Total rise in blood glucose: 34.94 mg.

Time of greatest rise following glucose injection: 20 minutes.

* This figure is not included in the rise in blood glucose.

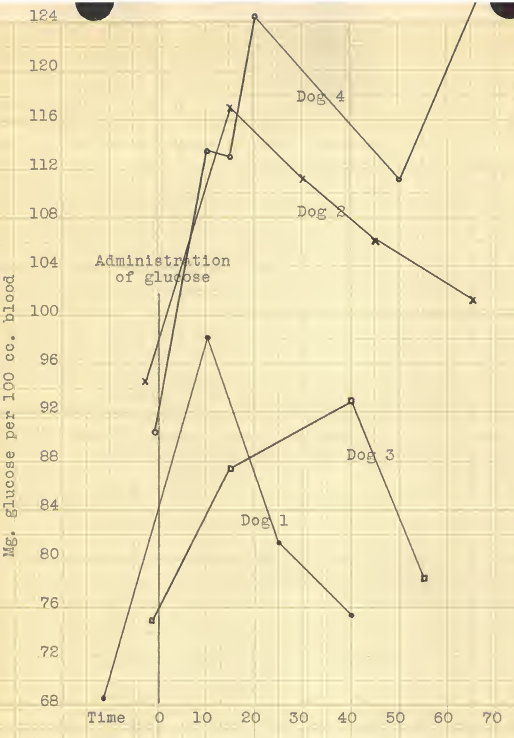

Fig. 1. Rise in blood sugar following intragastric injection of fifty per cent glucose solution.

(2) Four per cent glucose experiments: It was found that when a four per cent solution of glucose was injected into the stomach, the total increase in blood sugar was similar to that in animals in which a fifty per cent solution was administered. However, the time necessary for the increase to become evident following the introduction of the sugar solution was greater than in the first group of experiments.

Two dogs were included in this group. Dog 5 exhibited a total rise of 21.88 mg. of glucose per 100 cc. of blood in 55 minutes. The blood sugar of Dog 6 increased 26.56 mg. in 25 minutes. According to the results obtained in these two tests, it was found that the average total rise was 23.72 mg. in an average time of 40 minutes.

Although the total rise in blood sugar in this group of experiments correspond quite closely to that of group (1), the time necessary for the increase to become manifest was more than twice that of the first group. It was concluded, therefore, that the rate of absorption is dependent upon the concentration of the glucose solution present. However, it was also concluded that the concentration of the glucose solution may be less than five per cent in order to be absorbed.

The individual results of the tests in this group are on the following pages.

Table 2 (a). Four Per Cent Glucose Experiments.

Dog 5. (One year old male; weight 35 pounds)

Time	Minutes after glucose	Treatment	Mg. glucose in 100 cc. blood
9:25 a.m.		8 cc. Nembutal intravenously	
9:40 a.m.		6 cc. blood from gastric vein	62.50
9:43 a.m.	0	20 cc. 4% glucose solution into stomach	
9:58 a.m.	15	6 cc. blood from gastric vein	72.46
10:15 a.m.	32	6 cc. blood from gastric vein	76.33
10:38 a.m.	55	6 cc. blood from gastric vein	84.38

Total rise in blood sugar: 21.88 mg.

Time of greatest rise following glucose injection: 55 minutes.

Table 2 (b). Four Per Cent Glucose Experiments.

Dog 6. (Ten month old male; weight 40 pounds)

Time	Minutes after glucose	Treatment	Mg. glucose in 100 cc. blood
8:50 a.m.		10 cc. Nembutal intravenously	
9:10 a.m.		6 cc. blood from gastric vein	82.72
9:15 a.m.	0	20 cc. 4% glucose solution into stomach	
9:25 a.m.	10	6 cc. blood from gastric vein	104.16
9:40 a.m.	25	6 cc. blood from gastric vein	109.28
10:05 a.m.	50	6 cc. blood from gastric vein	105.26
10:30 a.m.	75	6 cc. blood from gastric vein	101.52

Total rise in blood sugar: 26.56 mg.

Time of greatest rise following glucose injection: 25 minutes.

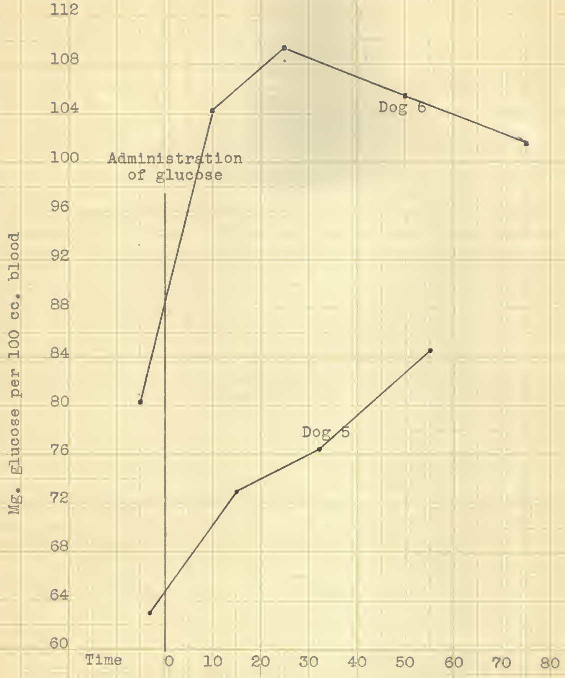

Fig. 2. Rise in blood sugar following intragastric injection of four per cent glucose solution.

(3) Physiological saline solution control experiments: The two dogs used in this group exhibited relatively constant levels of blood glucose following the administration of physiological saline solution into their stomachs. Although the initial values were different, the levels remained about the same throughout the test period.

It was concluded from the results obtained, which are tabulated individually on the following pages, that the blood sugar level is not increased when a solution other than glucose is present in the stomach.

Table 3 (a). Saline Control Group.

Dog 7. (Two year old male; weight 25 pounds)

Time	Minutes after saline	Treatment	Mg. glucose in 100 cc. blood
10:10 a.m.		5 cc. Nembutal intravenously	
10:35 a.m.		5 cc. blood from gastric vein	85.46
10:42 a.m.	0	25 cc. 0.85% NaCl solution	
10:52 a.m.	10	5 cc. blood from gastric vein	85.83
11:07 a.m.	25	5 cc. blood from gastric vein	87.33
11:27 a.m.	45	5 cc. blood from gastric vein	84.92

Table 3 (b). Saline Control Group.

Dog 6. (One year old male; weight 15 pounds)

Time	Minutes after saline	Treatment	Mg. glucose in 100 cc. blood
9:20 a.m.		5 cc. Nembutal intravenously	
9:40 a.m.		5 cc. blood from gastric vein	103.68
9:45 a.m.	0	20 cc. 0.85% NaCl solution into stomach	
10:00 a.m.	15	5 cc. blood from gastric vein	104.74
10:15 a.m.	30	5 cc. blood from gastric vein	108.04
10:40 a.m.	55	5 cc. blood from gastric vein	102.82

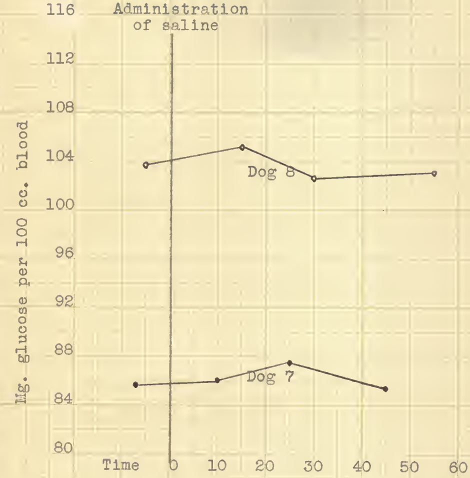

Fig. 3. Blood sugar level following intragastric injection of physiological saline solution.

(4) Anesthetic and manipulation control experiments: The results obtained in the three test animals included in this group indicated that the anesthetic which was employed and that handling of the stomach and removing blood from the gastric veins did not produce hyperglycemia. Dog 10 showed an increase in blood sugar of 12.82 mg. per 100 cc. of blood between 20 and 35 minutes following the injection of the anesthetic solution. This increase was probably due to the fact that the animal showed signs of recovering from the effects of the anesthetic during the operative procedure and struggled considerably. Excitement of this sort is known to produce temporary hyperglycemia due to the excessive release of the adreno-medullary hormone, epinephrine. However, after a short period of time, the blood sugar level returned to normal.

Tabular results of these experiments are given on the following pages.

Table 4 (a). Anesthesia and Manipulation Control Group.

Dog 9. (Three year old male; weight 35 pounds)

Time	Minutes after Nembutal	Treatment	Mg. glucose in 100 cc. blood
8:35 a.m.		5 cc. blood from external saphenous vein	81.14
8:40 a.m.	0	8 cc. Nembutal intravenously	
9:15 a.m.	35	5 cc. blood from gastric vein	79.52
9:40 a.m.	60	5 cc. blood from gastric vein	83.33

Table 4 (b). Anesthesia and Manipulation Control Group.

Dog 10. (Aged male; weight 60 pounds)

Time	Time after Nembutal	Treatment	Mg. glucose in 100 cc. blood
1:25 p.m.	0	14 cc. Nembutal intravenously	
1:55 p.m.	20	6 cc. blood from gastric vein	74.48
2:10 p.m.	35	6 cc. blood from gastric vein	87.10
2:30 p.m.	55	6 cc. blood from gastric vein	75.75
2:50 p.m.	75	6 cc. blood from gastric vein	75.75

Table 4 (c). Anesthesia and Manipulation Control Group.

Dog 11. (Two year old male; weight 45 pounds)

Time	Minutes after Nembutal	Treatment	Mg. glucose in 100 cc. blood
1:25 p.m.	0	10 cc. Nembutal intravenously	
1:55 p.m.	30	6 cc. blood from gastric vein	72.33
2:15 p.m.	50	6 cc. blood from gastric vein	72.46
2:40 p.m.	75	6 cc. blood from gastric vein	73.12

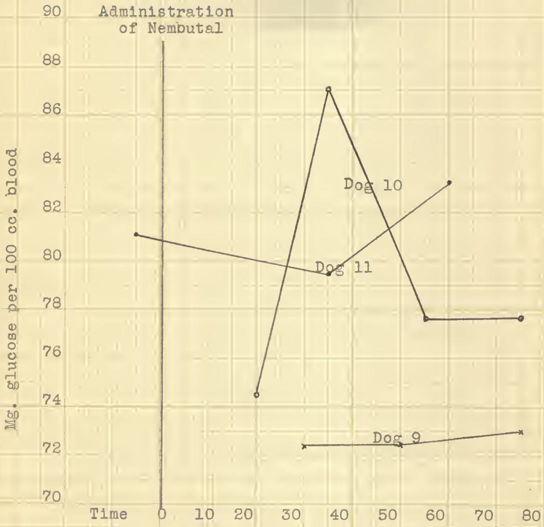

Fig. 4. Blood sugar levels following injection of Nembutal and manipulation of the stomach.

SUMMARY

It was the author's contention that absorption from the stomach could be detected by an increase in blood glucose following the intragastric administration of a solution of glucose, when there were no extraneous hyperglycemic factors present. The test animals used in this series of experiments had been starved for a period of 12 to 24 hours previous to the time of operation, and their stomachs and intestines were empty. Control experiments showed conclusively that a rise in blood sugar could not be induced by the presence of solutions other than those of glucose in the isolated stomach. The anesthetic employed and manipulation of the stomach were also shown to be without hyperglycemic effects. Because the pylorus and esophagus of each of the test animals were securely ligated, and the solutions which were injected into the stomach of each dog could not have been forced into any other portion of the alimentary tract, it was decided that any evident increase in blood sugar must be due to absorption of glucose by the gastric mucosa.

The dogs into which glucose solutions were injected showed an increase in blood sugar (25-33 per cent)which was sufficiently large to convince the author that it was due to absorption by the stomach of the glucose which was present therein. The results obtained by comparing the time necessary for absorption of low and high concentrations of glucose indicated that the rate of absorption depended upon, and was directly proportional to, the concentration of the glucose present in the stomach, a longer period of time being necessary for absorption of the same amount of glucose in low concentration than in high concentration.

It was noted throughout these experiments that the normal amount of glucose in the blood within the species was subject to wide variation, ranging from 62.50 mg. to 103.62 mg. per 100 cc. of blood.

CONCLUSIONS

From the results noted in this series of experiments, it was concluded that

(1) Glucose is absorbed by the gastric mucosa,

(2) The rate of absorption varies directly with the concentration of glucose solution present in the stomach,

(3) The presence of a solution other than one of glucose in the stomach does not cause an increase in blood sugar,

(4) The anesthetic (Nembutal) which was employed in these experiments has no hyperglycemic effects,

(5) The operative procedure and manipulation of the viscera to which the test animals were subjected do not have any influence on the blood sugar level, and

(6) The normal amount of blood glucose is subject to wide variation within the species.

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